

A Comprehensive Assessment And Future Research Directions For Exploring Future Iot Technologies In Smart Health Research

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Abstract— The main objective of this study was to assess the research directions of IOT technologies in meeting the demands of smart health research. Technology is changing the delivery and access to healthcare services around the world in many ways. One of these technologies is the IOT has brought unprecedented impact on healthcare service delivery. IoT technologies are becoming more impactful to healthcare in many ways. Healthcare practitioners can now diagnose, treat, and monitor their patients remotely using IOT devices integrated with medical systems [1]. Remote monitoring of patients has allowed healthcare practitioners to track the progress of their patients in real-time. They can also receive quick feedback allowing more personalized healthcare to the patients. This tremendous impact is expected to increase exponentially especially in keeping the patients safe and improving the methods of healthcare delivery [1]. IOT also improves patient satisfaction through direct interaction with their physicians. It also can increase the efficiency of other technologies like Electronic Health records systems. Integrating IoT in medical devices will improve the precision and accessibility of better healthcare. The end goal of integrating IOT into medical services is to ensure faster delivery of service while allowing health practitioners to get closer to the patients [2].

Keywords— IoT, healthcare, scientific research, automation, data collection, predictive analytics, telemedicine, EHRs

I. INTRODUCTION

With the modern advancement of technology in healthcare, IoT is emerging as an increasingly important tool in the delivery of medical services. This impact is increasing exponentially as the demand for fast delivery of services increases. Several aspects of IoT make IoT a standout among the other technologies in healthcare. Some of these aspects range from machine control and virtual medical assistance that has been around the world. The IoT impacts have not been fully explored in

terms of how it works in healthcare and what can be done to achieve the needs of the healthcare system [2].

Technology is saving lives in many areas from diagnosis to research of medical interventions of emerging diseases. Smart health which is the integration of IOT in healthcare is reshaping the delivery, and monitoring of healthcare services. This is driven by the IoT which connects many aspects of healthcare including data, systems, and devices. This interconnectedness enables a seamless information exchange in one ecosystem with various components. The IoT is also proving to be efficient in streamlining the clinical workflows and patient outcomes. IOT is projected to generate over \$200 Billion by 2021 which is 21% in CAGR by the healthcare market. Accenture survey also shows that 73% of healthcare executives believe IoT is emerging as a revolutionizing technology that will overtake the traditional healthcare models in the next 3 years. It is also projected that the remote marketing technology will surpass the \$31 Billion mark with a 17% CAGR by 2028.

Recent studies have shown that IoT has the potential to improve the management of chronic diseases, especially with the use of wearable IoT devices. IoT devices will also change the delivery of real-time health to the elderly by enabling the monitoring and detection of diseases early before they become chronic. This will have a tremendous impact on the healthcare system by reducing the number of hospitalizations and minimizing the pressure and burden on the healthcare system. There will also be an improvement in specialized medical services especially for people living in remote environments through the IoT-based monitoring systems.

As the IOT-based systems evolve in the healthcare sector more research is needed to understand its implementation and future research impacts and its benefits to the delivery of smart health. It is imperative to assess how IoT-based technologies can be unlocked to achieve their full

potential in healthcare and the delivery of medical services. This is why this paper will look at exploring the current IoT environment in supporting healthcare services and its future developments to realize its full potential in offering smart health. This will provide future research directions on its benefits and challenges while also advancing the current realm of smart health.

II. RESEARCH PROBLEM

The main problem that this study will solve is to explore how IoT technologies are addressing emerging issues in healthcare research. An array of problems may surface when transferring data to other parties, a task that the Internet of Things (IoT) significantly simplifies. IoT sensors streamline the process by transmitting data to all relevant stakeholders at the point of collection, ensuring no information gets lost in translation. Even though modern research tools have evolved rapidly over time[6], resources accessible to healthcare professionals still lack vital real-life observations. Much of medical research done using IoT tech hinges primarily on historical cases, controlled environments, and physical medical check-ups. Integration of IoT tech grants entry to more valuable and precise data extracted through real-time analysis and field testing[6]. Similar to its influence in other sectors, IoT tech's impact can overhaul healthcare by providing data superior to traditional analytics. This possibility is enabled through sophisticated instruments with extensive research capabilities. Consequently, IoT-driven healthcare solutions offer more practical and dependable data making the pursuit of better medical solutions or uncovering hitherto unknown issues not just more accessible but also more precise than extant research modes[6]. Research powered by IoT yields profound insights into patient well-being, diseases, and the development of medical interventions [7].

III. LITERATURE REVIEW

A. IoT in healthcare

Recent research studies have shown that IoT penetrates the healthcare sector rapidly and does not show any signs of slowing down. Some of the major aspects of healthcare that have benefited a lot from IoT include public health and remote monitoring of patients through a virtual network. One of the major areas of IoT-based systems that is now popular is the Internet of Medical Things (IoMT). This technology is rapidly changing the delivery of medical services in public health through virtual networks. The integration of the Internet of Medical Things (IoMT) in healthcare requires interconnected devices that

work seamlessly to collect patient data in real time[7,8] The collection of patient data has been one of the key areas that has been slowed down by traditional and manual methods. The Internet of Medical Things is proving to be significant in solving various medical issues, especially the diagnosis of diseases, prevention, and treatment of diseases. This is attributed to the rapid collection of data to make informed medical interventions. IoMT is also lessening the frequent visits to hospitals by helping doctors to monitor their patients remotely.

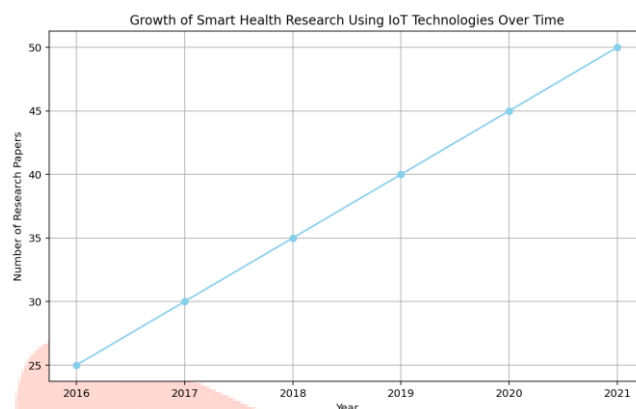


Fig i: The growth of smart health research using IoT technologies

Data for Research:

IoT has proven to be important in medical research and the future directions of healthcare systems. There are many areas in medical research where IoT will prove more significant. For instance, IoT devices are being used in medical research to collect real-time data, improving patient monitoring and helping the diagnosis and treatment of emerging diseases[9,10]. With these research benefits, IoT is proving to be significant in saving time and money that would otherwise be burdening using traditional methods. Remote monitoring is an important aspect of IoT that is changing how health practitioners monitor signs and symptoms of diseases among many patients. Some of the common IoT devices used in remote monitoring include fitness trackers, smartwatches, and sensors embedded in wearable devices. Health practitioners can easily track various disease signs like blood pressure, sleep patterns, heart rate, glucose levels, etc. Healthcare practitioners can receive these data in real-time to enable them to make personal treatment plans.

Additionally, IoT is enabling clinical trials and drug development by supporting the collection of data and allowing for accurate analysis and submission of results. Some of the aspects that IoT has proven to be effective are the monitoring of a patient's adherence to medication, their response to

medication, and the overall outcome of the treatment plan. Data collection and analysis is also a major area in which IoT is proving to be impactful. Researchers can now collect a large volume of data and analyze it in real-time. This allows for rapid analysis of data and insights to assess disease patterns, individual health progress, and environmental factors affecting the progression of diseases. The collection of a vast amount of data also supports the analysis and identification of the correlations and the potential risk factors for disease progression.

Healthcare Research data

A vast amount of healthcare data can now be collected in real-time using IoT devices like smartwatches and fitness trackers. IoT data can be used for disease intervention in clinical trials. IoT data needed for clinical trials are divided into two categories: data gathered as per the protocol and data collected for future trials[9,10]. The latter is significant in future medical research, especially in targeting respondents for subsequent clinical trials [11]. Data gathered as per protocol occurs at the trial site and is often described as a decentralized form of data collection. This type of IoT data occurs more frequently for the same data points. The second IoT data occurs in an unstructured environment and allows data to be put in a new context [11]. Researchers must utilize the collected data to support clinical trials and future medical research [11,12].

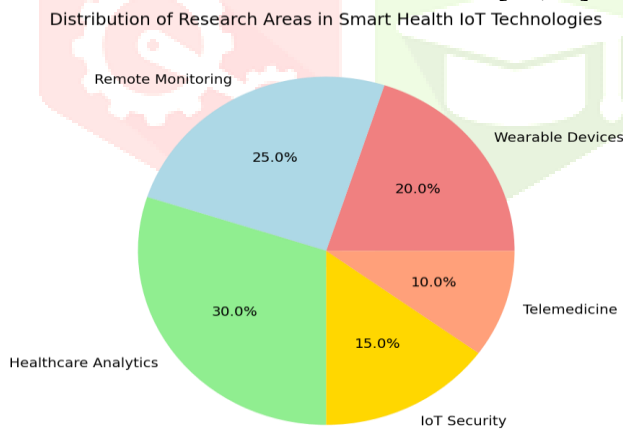


Fig ii: Distribution of Research areas in smart IoT technologies

The emergence of IoT technology is gaining a lot of popularity in data collection and supporting medical research outcomes. Such data can be important in exploratory research, especially in identifying research biomarkers that can be used to develop a pipeline [12]. Data can be significant in identifying meaningful trends in trials or disease progression. They should be protected and set a clear hypothesis that will guide research in a structured

way [13]. The collection of these data must be done with the full consent of the patients to ensure there is a seamless research process with an exploratory element[14].

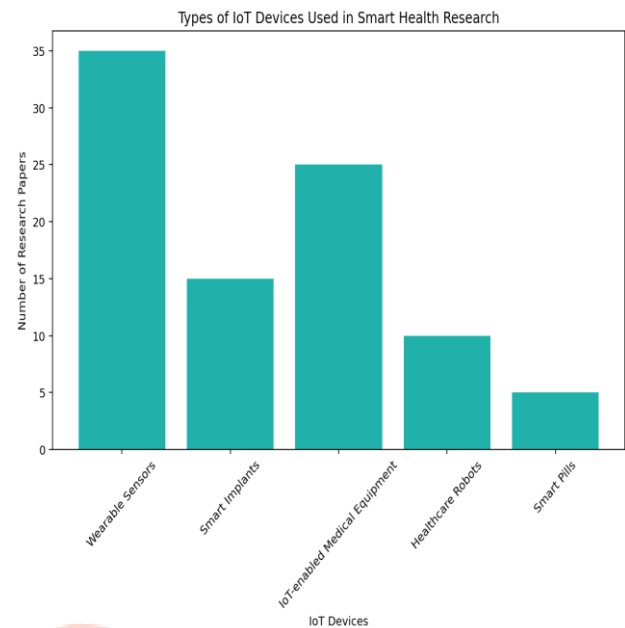


Fig iii: IoT Devices Used in Healthcare Research Predictive Maintenance

IoT is also having a tremendous impact on the maintenance of research equipment. Laboratories are now utilizing IoT devices to improve their maintenance schedules to make sure the research outcomes are accurate. Long-term use of equipment can lead to wear and tear and therefore must be maintained regularly to prevent leakages and errors in experimental trials. IoT devices with integrated sensors can offer predictive capabilities to detect sub-optimal conditions in these equipment. This will minimize cases of inaccurate readings that could affect the efficacy of an experiment[14]. Predictive maintenance is important in research experiments to assess when equipment needs repairs or alert researchers on maintenance issues for immediate mitigation. Conventional methods have been affecting research trial outcomes due to their failure to identify performance problems in equipment. This would usually be expensive and time-consuming owing to the frequent repairs and waste of research materials. Researchers have projected an 18% to 25% reduction in maintenance costs when IoT devices and sensors are integrated into laboratory equipment [14,15].

IV. SIGNIFICANCE AND BENEFITS

DevOps has proven to be effective in e-learning, especially for academic institutions and corporate environments. DevOps has proven to be effective in making the workflows more efficient and seamlessly running operations. Higher institutions are gaining a

lot from the integration of DevOps in their learning environments. Professors can now teach and help students in running tests on their code. They can also run the installation and release of applications faster than traditional practices. DevOps best practices of high velocity contribute immensely to the increased efficiency of software development and operations [14,15]. Businesses need to increase their operations and the working efficiency of their teams. E-learning is proving to be effective in collecting data for prediction of various aspects of their businesses. The integration of DevOps allows employees to work as a team to meet the deadlines of various projects. DevOps introduces a culture of collaboration to achieve the set goals and outcomes. The traditional manual practices have been eliminated by DevOps best practices by reducing the considerable time needed to execute, report, and monitor projects. Stakeholders are utilizing DevOps tools to construct standard pipelines, especially in implementing software.

V. FUTURE

The future of E-learning will see more integration of DevOps in learning and training many people. This is already being done in classrooms and businesses but more progress is expected in the future. It is expected that DevOps will increase the employability of graduates and job applicants as more students will earn the requisite skill sets for various industries. There should be a lot of awareness and knowledge of the best practices and the new experiences brought by DevOps [19,20]. DevOps integration needs to be made a constant influence on the already stimulated education industry. Its benefits will expand workforce development and increase the competencies in the corporate sector [19]. DevOps will change the culture of classroom learning into a more collaborative one. This will accelerate the digital transformation in the classroom and increase the benefits to the digital world in terms of innovation and competencies of employees.

V. CONCLUSION

The main aim of this paper was to explore the integration of DevOps in e-learning. The findings show that DevOps is gaining a lot of popularity in the education and corporate world. It is increasing the efficiency of workflows and digital learning by creating a seamless learning process. One of the significant areas of contributions in e-learning is the automation of processes and revolutionizing the systems run by various institutions. Additionally, DevOps has become the mainstream tool breaking boundaries between e-learning development and

operations. Organizations can take advantage of DevOps practices to resolve the many challenges they face in terms of making their operations agile. DevOps also can improve communication and collaboration due to its automation and tooling aspects. Organizations can apply these aspects in their software delivery processes to bring together workflows. This also enables a physical combination of responsibilities of DevOps to set a strong culture between teams. A team with strong cultural norms can facilitate communication and information sharing efficiently. They can use chat applications and wikis in communication and sharing of information to run the operations. This is also important in ensuring that information across developers is faster and more efficient tracking of projects.

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